

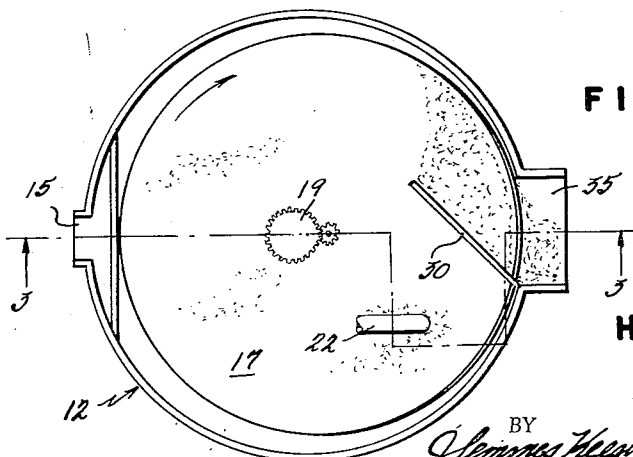
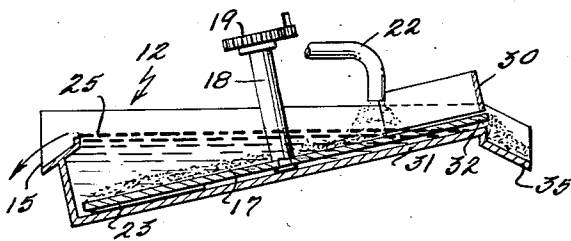
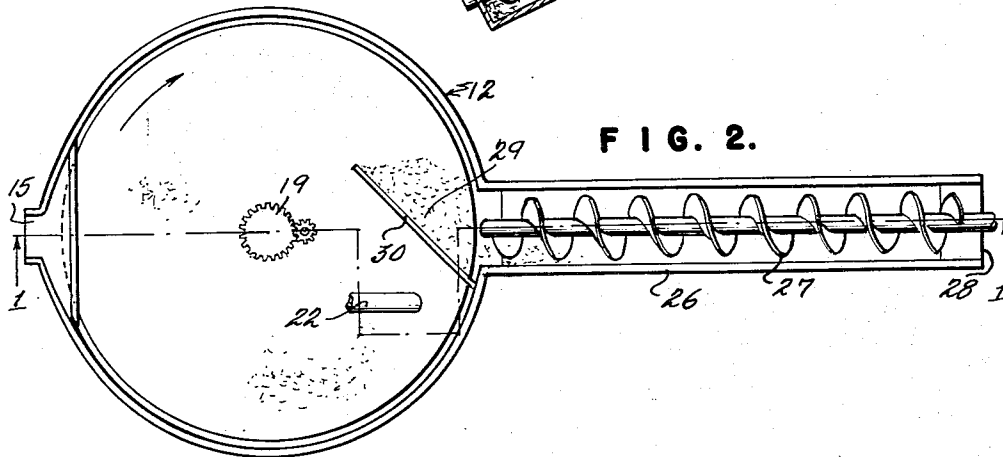
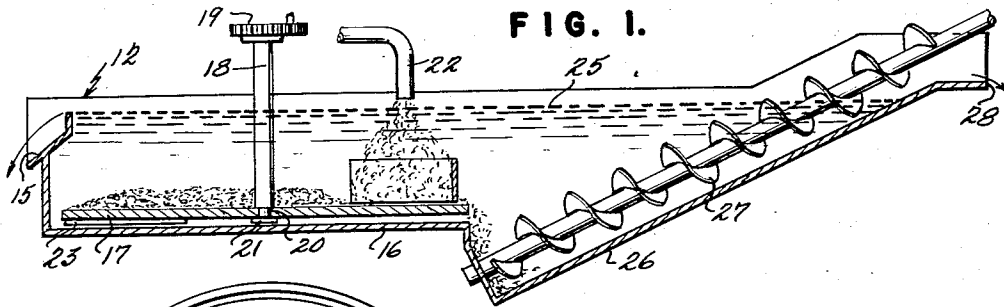
Jan. 15, 1957

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2,777,580

Filed Oct. 13, 1951

4 Sheets-Sheet 1



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Filed Oct. 13, 1951

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FIG. 5.

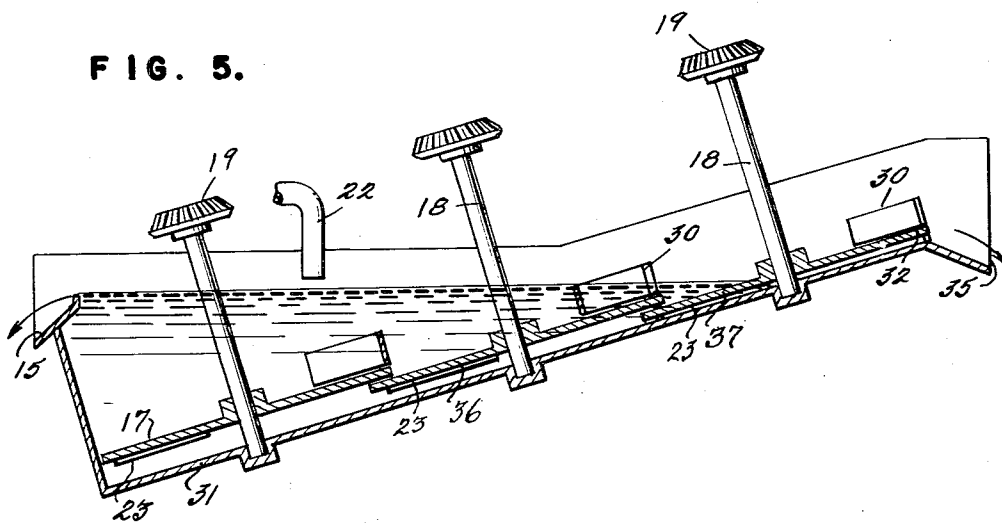


FIG. 6.

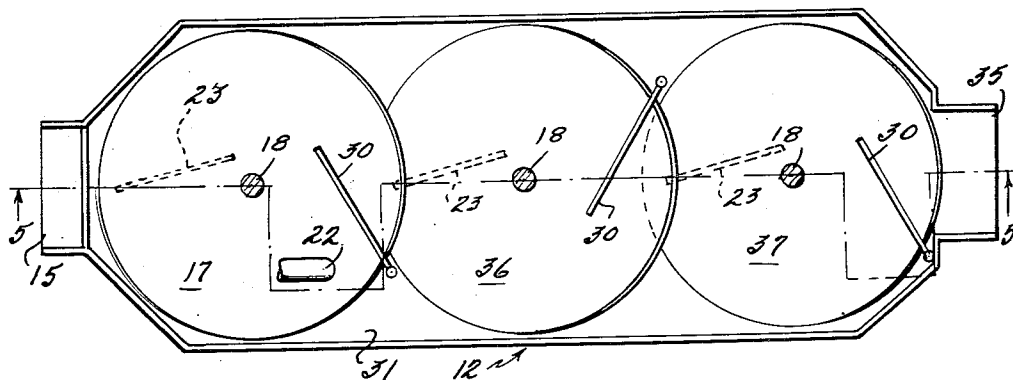


FIG. 9.

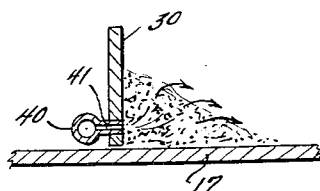
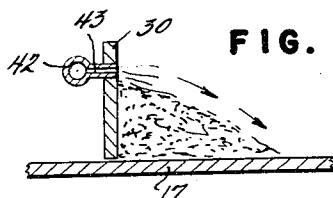


FIG. 10.



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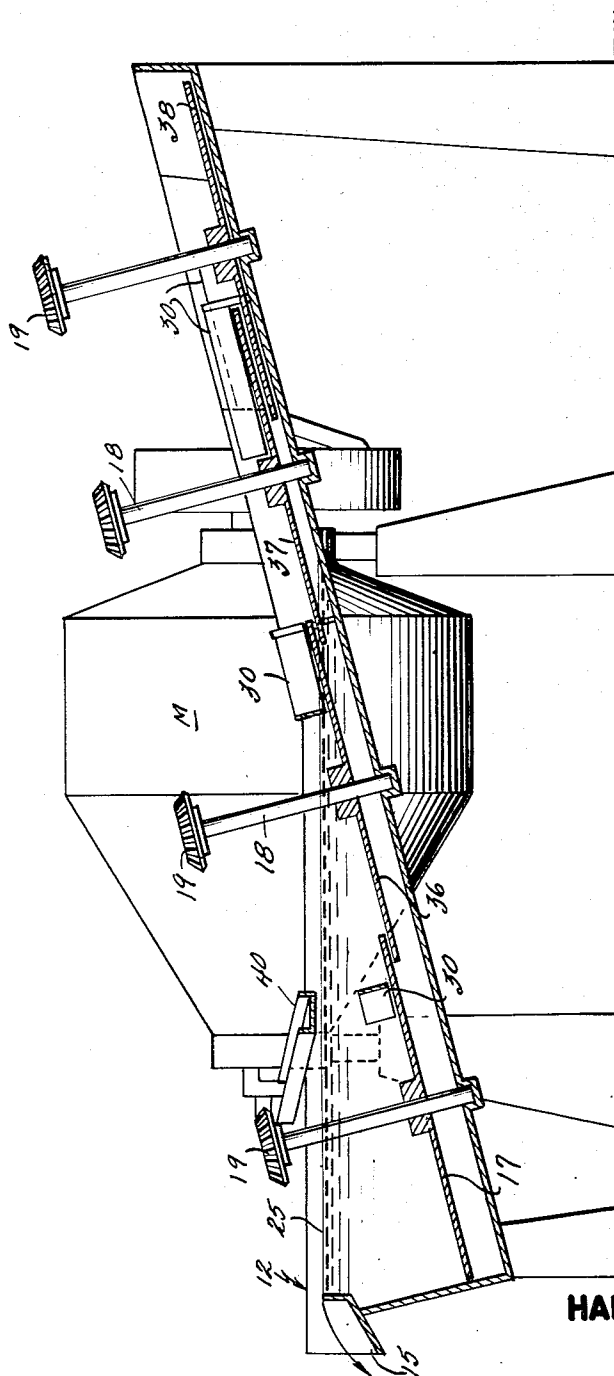
Jan. 15, 1957

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2,777,580

Filed Oct. 13, 1951

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CLASSIFIER

Filed Oct. 13, 1951

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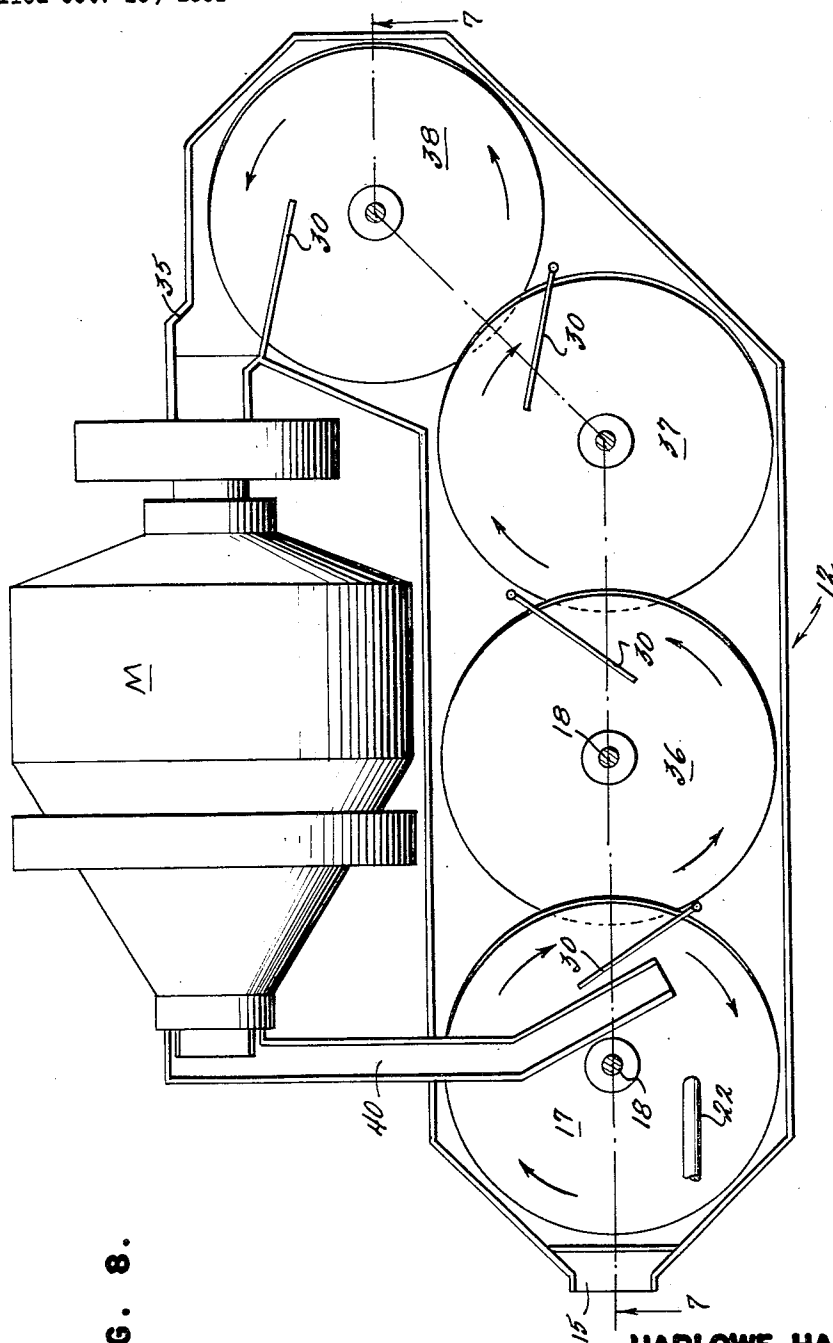


FIG. 8.

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Application October 31, 1951, Serial No. 254,001

13 Claims. (Cl. 209—444)

This invention relates generally to classifying apparatus and more particularly to apparatus for separating particles which settle at different rates in a liquid.

This application is a continuation-in-part of my co-pending application Serial No. 721,679, filed January 13, 1947, now Patent No. 2,577,754, for a "Classifier" containing claims to a method of classifying particles by separation.

The present apparatus is intended for the separation of materials which have different settling rates in liquid such as water; for instance, iron ore which contains materials of varying density such as silica and iron oxide. In free settling through water, the particles which are the first to settle to the bottom of any container may be the smaller rather than the larger particles, if the smaller particles are of the heavier material. Where the material is composed of particles all of which are homogeneous, the size is ordinarily the determining factor in the rate of settling. It is to be understood that this invention relates to the separation of particles of different rates of settling.

In general, the invention comprises apparatus including a surface or platform moving beneath a liquid into which unsized pulp is dumped or fed. Some of the fines in the pulp remain in suspension in the liquid and the coarse particles settle upon the moving platform carrying with them the remaining fines. However, because the moving platform is in motion through the liquid, for instance water, these fines tend to be dislodged from the coarse particles by reason of the washing action of the water on the coarse particles after they have come to rest on the platform. Thus, there is a continual washing action which tends to maintain the fines in suspension, and the eddy currents created by the motion of the deposited material on the moving platform under the liquid keeps the fines from settling, and even causes them to be brought again into suspension after they have started to settle.

This type of classifier may be used with grinding mills in accordance with common practice.

The unsized pulp is fed to the classifier at the influent end a reasonable distance away from the fines overflow point. The coarse particles may be sent again to the mill to be reduced in size and may be re-fed to the classifier. It is obvious that a change in speed of the moving platform will also affect the fines discharge. At very low speeds, the moving platform will cause negligible disturbance near the bottom with the result that fines, in addition to the coarse particles once deposited on the platform, will tend to remain there and be carried up to the discharge with the pre-settled coarse particles. The faster the movement of the platform, the greater is the agitation adjacent to it, and the greater the tendency to keep the finer particles in suspension. If the finer particles of a given size cannot remain on the moving surface without being washed off, they will stay in suspension and become part of the fluid medium, with the result that when a sufficient number are present in the fluid

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medium, they will flow as fines over the overflow end of the classifier with the liquid.

The action and principles of this moving platform classifier are radically different from other types that scrape the solids by rakes, drags, or screw flights over a stationary surface. In these types coarse particles and fines are mixed together, or fines are drained through the coarse particles, thus holding them in the mass. The principle of the present invention of depositing the unsized pulp on the moving submerged surface permits the fines next settling on the moving surface to be washed back into the liquid where they can be delivered to the fines discharge point. The scraper which is employed to remove the particles deposited on the moving platform has in itself a squeezing action on the deposited particles, and liquid and fines are forced out. Thus, the material on the platform gets an additional desliming as well as a dewatering action.

In the drawings:

Figure 1 is a vertical sectional view, taken along the line 1—1 of Figure 2, of one form of my apparatus which employs a horizontal rotating disc;

Figure 2 is a top plan view thereof;

Figure 3 is a vertical sectional view taken on the line 3—3 of Figure 4 of another form of the invention;

Figure 4 is a top plan view thereof;

Figure 5 is a vertical sectional view of a further form of the invention, taken on the line 5—5 of Figure 6;

Figure 6 is a top plan view thereof;

Figure 7 is a vertical sectional view of a still further form of the invention, taken on the line 7—7 of Figure 8;

Figure 8 is a top plan view thereof;

Figure 9 is a detail view showing one form of baffle with the water discharge therethrough; and

Figure 10 is a detail view showing another form of baffle with the water discharge therethrough.

Referring to the drawings, numeral 12 designates a tank which is circular in configuration and provided with a fines overflow discharge chute 15. Adapted to rotate near the bottom 16 of the tank 12 is a disc 17 suspended on a shaft 18 which is driven by suitable gearing 19 connected to a source of power, not shown. The shaft 18 is restricted in diameter as illustrated at 20 where it passes through the disc 17 and a holding nut 21, or other similar holding member, holds the disc 17 on the shaft 18 so that it is rotated with the shaft 18.

Unsize pulp is fed through a duct 22 onto the surface of water 25 in the tank 12. The tank is provided with a collecting trough 26 at one end, in which is mounted a conveyor screw 27 driven by a source of power, not shown; which is adapted to deliver the coarse washed sands to a coarse sands discharge outlet 28.

Adapted to scrape the coarse particles 29 from the disc 17 is a scraper member 30. It has been found that the scraper 30 should be set at enough of an angle to the direction of motion of the coarse particles 29 to scrape them off without permitting them to be piled up to too great an extent adjacent the scraper. In other words, the angle of the scraper, it has been found, should be set so as to feed the coarse particles with comparative ease into the discharge chute 26.

Referring to Figures 1 and 2 of the drawings, it will be seen that the unsized pulp is fed through the feed pipe 22 onto the rotating disc 17, and falls through the water 25 onto the disc. While falling through the water, the fines become suspended in the water. The coarse particles, after they near the upper surface of the rotating disc 17 and when they touch the rotating disc, are subjected to eddy currents which wash out more of the fines. These fines in suspension pass over the fines overflow 15. The coarse particles on the disc 17 are subjected to a washing action by the water during the rotation of the

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disc until they reach a point adjacent the scraper 30, at which point they are scraped off into the discharge chute 26. The material scraped off the disc 17 falls into the bottom of the chute, and is fed by the conveyor screw 27 to the coarse sands discharge point 28. Here the coarse particles can be sent again to the mill and re-fed through the unsized pulp feed pipe 22 for re-processing. The bottom surface of the disc 17 is provided with one or more narrow radial scraper vanes 23 to keep materials from building up underneath the disc 17 as it rotates in the flow.

The great efficiency of the present invention is in part due to the eddy currents adjacent the surface of the disc. The coarse particles as they approach the disc 17 are subjected to a washing because of these eddy currents which loosen the fines and tend to keep them in suspension. Moreover, the particles, after they rest on the upper surface of the disc 17, are subjected to eddy currents and washing as the deposited particles move along with the rotating disc. This tends to remove the fines from the coarse particles and causes a very efficient operation of the classifier.

The coarse particles and the fines are not mixed together and the fines are not drained through the coarse as has been the case with other classifier systems. It is to be emphasized that the movement of the rotating platform or disc 17 causes the fines to be washed back into the liquid zone. Moreover, the action of the scraper 30 and the conveyor screw 27 is to squeeze the fines and the water out of the coarse particles just at the point that the coarse particles are discharged from the classifier.

The greater the speed of rotation of the disc 17, the greater is the washing action of the water. It is to be noted that there is greater washing action near the periphery of the disc 17 than near the center because of the greater speed of travel of points near the periphery than of points near the center.

The same principles of operation are true of the embodiment disclosed in Figures 3 and 4. In this case, the tank 12 is provided with an upwardly sloping bottom 31 and the disc 17 is arranged to rotate parallel to the bottom 31. The scraper 30 is set so as to scrape the higher side of the disc 17. The disc is arranged so that its higher side during its rotation continually emerges above the surface of the water 25 and there is a high portion of the disc 17 which lies above the water and is indicated by the numeral 32. It is preferable to scrape the coarse sands into a coarse sands discharge chute 35 by means of the scraper 30 positioned at the high point 32. Although the discharge position of the settled solids is shown as being above the surface of the liquid, they could be under the liquid but at a higher point than the lower point of the disc. The liquid adjacent the disc 17, in either case, tends to rotate with the disc and the solids on the disc but eddy currents are produced in the liquid.

When the discharge is above the surface of the water, some water is carried above the surface of the liquid and washes back, carrying with it those fines which are lightly resting on the disc or on the coarse particles on the disc. The liquid velocity at this point will carry them back and not permit them to be discharged with the more tenacious portion of the load which are the heavier, coarser sizes. The result of this action, particularly where the discharge is above the surface of the liquid, is that the fines will remain in suspension in the tank and they will be built up to a degree where they tend to remain in suspension, and eventually will go over as fines at the overflow 15.

Another form of the invention employing the principles set forth is shown in Figures 5 and 6. In this form of the invention, the suitably supported tank 12 is elongated as is the sloping bottom 31 to receive two additional rotatable discs 36 and 37, each provided with scrapers 30. The disc 17 is spaced from the bottom of the tank and its higher peripheral edge overlaps the lower edge of the disc 36 for a reason which will become apparent. Simi-

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larly, the higher edge of the disc 36 overlaps the lower edge of the disc 37 and the high point 32, as in the previous form of the invention, is adjacent the coarse sands discharge chute 35.

As shown in Figure 6, the discs 17 and 37 rotate clockwise while the disc 36 rotates counter-clockwise. In the operation of this form of the invention it will be seen that the unsized pulp is deposited by the pipe 22 into the tank above the disc 17, the fines floating and the coarse particles settling onto the rotating disc 17. As the disc rotates, the coarse particles are squeezed and transferred to the oppositely rotating disc 36 by the scraper 30. The particles are thus further agitated with additional fines being separated from the coarse particles which are transferred to the oppositely rotating disc 37 by the scraper 30 when the operation is repeated. As the high point 32 of the disc 37 is out of the water 25, the scraper will squeeze the coarse particles at this point and discharge them into the chute 35. It will be readily apparent that the more thorough classifier action is provided by this form of the invention.

A further form of the invention also employing the classifier principles set forth herein is shown in Figures 7 and 8. This form of the invention is similar to the form shown in Figures 5 and 6 except that an additional rotating disc 38 is employed and positioned out of line with respect to the discs 17, 36 and 37. Thus, the fines overflow discharge chute 15 is out of line with the coarse sands discharge chute 35 which is shown as discharging into a ball mill M. The reground unsized pulp is then discharged into the tank 12 directly over the disc 17 by the chute 40 where it is again classified in the manner described. It will be noted that in this form of the invention only the discs 17 and 36 are submerged in the water 25.

Under certain circumstances it is desirable that additional liquid be added in the scraper zone. While the scraper could be hollow and be provided with parts and a source of fluid, I have shown in Figures 9 and 10 two alternate methods of supplying water to the scraper zone. In Figure 9, a pipe 40 having a nozzle 41 is fixed to the scraper 30 adjacent its lower edge and connected to a source of fluid which is discharged through the solids. In Figure 10, I have shown a pipe 42 having a nozzle 43 which discharges fluid over the solids.

The addition of relatively clean liquid in the scraper zone enables a further desliming action to be obtained. This added fluid tends to carry away with it more of the slimes and fines of a size smaller than that forming the major portion of the mass, thus creating an additional sizing action by returning these fines and slimes back into the pool with the liquid and permitting the scraped sands to be discharged with less unwanted fines or slimes therein.

The scrapers 30 acting with the various discs effect a very thorough washing and desliming of the oversize or coarser particles which are also thoroughly squeezed thereby and rendered suitable for feeding to the ball mill. The pulp is thus submitted and resubmitted to the ball mill and classifier until it passes over the discharge chute 15 as fines. It will thus be readily apparent that the apparatus comprising the present invention does not wash the fines through the coarse particles but prevents the mixing of the fines and coarse particles to a greater extent than is possible by the usual scraping with rakes, or by employing drags or screw flights over a stationary surface.

It is to be understood that the forms of the invention herewith shown and described are to be taken as preferred examples of the same and that various changes in the shape, size and arrangement of parts may be resorted to without departing from the spirit of the invention or the scope of the subjoined claims.

I claim:

1. An apparatus for classifying particles which settle

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at different rates in a liquid comprising a container having a liquid therein, means for discharging particles to be classified into the container, a disc in the container upon which the settled particles are adapted to collect lying underneath the surface of the liquid, means to rotate the disc whereby eddy currents are generated in the liquid, and stationary scraper means angularly disposed across a portion of said disc surface to remove continuously the settled particles from said disc.

2. A classifier comprising a tank for liquid, a rotating disc at least partially submerged under the surface of the liquid and having its surface at an angle to the horizontal surface of the liquid, means for discharging liquid and solids into the tank onto the rotating disc, means for discharging liquid with suspended solids therein from the tank, and a scraper for removing continuously the solids that have settled on the rotating disc said scraper being positioned at a point near the high point of the disc.

3. An apparatus for classifying particles which settle at different rates in a liquid comprising a container having a liquid therein, means for discharging particles to be classified into the container, a disc upon which the settled particles are adapted to collect lying underneath the surface of the liquid and having its surface inclined at an angle to the horizontal, means to rotate the disc whereby eddy currents are generated in the liquid, and a scraper to remove continuously the settled particles from said disc at a high point thereof.

4. A classifier comprising a tank for liquid, a rotating disc at least partially submerged under the surface of the liquid and having its upper surface at an angle to the horizontal surface of the liquid, means for discharging liquid and solids into the tank onto the rotating disc, means for discharging liquid with suspended solids therein from the tank, and means for removing continuously the solids that have settled on the rotating disc at a point near the high point of the disc, said liquid and suspended solids discharge being in actual alignment with said settled solids removing means.

5. A classifier comprising a tank for liquid, a plurality of rotating discs mounted in said tank and having their upper surfaces at an angle to the horizontal surface of the liquid, the major portion of the surface area of said discs being submerged beneath said liquid, means for discharging liquid and solids into the tank onto the rotating discs, means for discharging liquid with suspended solids therein from the tank, means for transferring settled solids upwardly from disc to disc to a high point of the discs and means for removing the solids from the tank.

6. A classifier comprising a tank for liquid, a plurality of rotating discs mounted in said tank and having their upper surfaces at an angle to the horizontal surface of the liquid, the major portion of the surface area of said discs being submerged beneath said liquid, means for discharging liquid and solids into the tank onto the rotating discs, means for discharging liquid with suspended solids therein from the tank, means for transferring settled solids upwardly from disc to disc to a high point of the discs and means for removing the solids from the tank, said last mentioned means comprising a discharge chute and a scraper blade positioned in said tank closely adjacent the upper surface of said point to divert the solids into the chute.

7. A classifier comprising a tank for liquid, a plurality of rotating discs mounted in said tank and having their upper surfaces at an angle to the horizontal surface of the liquid, the major portion of the surface area of said discs being submerged beneath said liquid, means for discharging liquid and solids into the tank onto the rotating discs, means for discharging liquid with suspended solids therein from the tank, means for transferring settled solids upwardly from disc to disc to a high point of the discs and means for removing the solids from the tank, said transferral means comprising a plurality of

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scraper blades mounted in the tank closely adjacent the upper surface of each disc at its high point and acting to divert settled solids from a disc to the next higher disc.

8. A classifier comprising a tank for liquid, a plurality of rotating discs mounted in the tank and having their upper surfaces at an angle to the horizontal surface of the liquid, a plurality of the discs being positioned above the surface of the liquid, means for discharging liquid and solids into the tank onto the submerged rotating discs, means for discharging liquid with suspended solids therein from the tank, and means for transferring the solids that have settled on the submerged rotating discs upwardly from disc to disc to the high point of the disc, and scraper means for removing the collected solids from the final disc, said scraper means acting to squeeze the moisture from the settled solids after their movement above the liquid level.

9. A classifier comprising a tank for liquid, a plurality of rotating discs mounted in the tank and having their upper surfaces at an angle to the horizontal surface of the liquid, a plurality of the discs being positioned above the surface of the liquid, means for discharging liquid and solids into the tank onto the submerged rotating discs, means for discharging liquid with suspended solids therein from the tank, and means for transferring the solids that have settled on the submerged rotating discs upwardly from disc to disc to a point near the high point of the discs, and scraper means for removing the collected solids from the final disc, said scraper acting to squeeze the moisture from the settled solids after their movement above the liquid level, said means for discharging liquid with suspended solids and said solids removing means being out of axial alignment.

10. A classifier comprising a tank for liquid, a rotating disc at least partially submerged under the surface of the liquid and having its surface at an angle to the horizontal surface of the liquid, means for discharging liquid and solids into the tank onto the rotating disc, means for discharging liquid with suspended solids therein from the tank, means for removing the solids that have settled on the rotating disc at a point near the high point of the disc, and means fixed to the bottom of said disc and effective to prevent the accumulation of solids thereunder.

11. A classifier comprising a tank for liquid, a rotating disc at least partially submerged under the surface of the liquid and having its surface at an angle to the horizontal surface of the liquid, means for discharging liquid and solids into the tank onto the rotating disc, means for discharging liquid with suspended solids therein from the tank, means for removing the solids that have settled on the rotating disc at a point near the high point of the disc, and means fixed to the bottom of said disc and effective to prevent the accumulation of solids thereunder, said last mentioned means comprising a substantially radially positioned scraper vane.

12. A classifier comprising a tank for liquid, a rotating disc at least partially submerged under the surface of the liquid and having its surface at an angle to the horizontal surface of the liquid, means for discharging liquid and solids into the tank onto the rotating disc, means for discharging liquid with suspended solids therein from the tank, and means for removing the solids that have settled on the rotating disc at a point near the high point of the disc, said last mentioned means including additional means for introducing fluid into the solids adjacent the scraper.

13. A classifier comprising a tank for liquid, a rotating disc at least partially submerged under the surface of the liquid and having its surface at an angle to the horizontal surface of the liquid, means for discharging liquid and solids into the tank onto the rotating disc, means for discharging liquid with suspended solids therein from the tank, and means for removing the solids that have settled

on the rotating disc at a point near the high point of the

disc, said last mentioned means including additional means
for introducing fluid over the solids adjacent the scraper.

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